Ontario Geological Survey

Northern Ontario
Engineering Geology Terrain Study 42

FRAZER LAKE AREA

(NTS 52H/SE)

District of Thunder Bay

by
D.G. Mollard and J.D. Mollard

Compliments of
ONTARIO
MINISTRY OF NORTHERN DEVELOPMENT
AND MINES

1981

Not for resale

Ontario

Ministry of Natural Resources

Hon. James A.C. Auld
Minister

W.T. Foster
Deputy Minister

Ministry of Northern Affairs

Hon. Leo Bernier
Minister

Art Herridge
Deputy Minister

93-02303/

© OMNR-OGS 1981
Printed in Canada

THIS PROJECT WAS FUNDED BY
THE ONTARIO MINISTRY OF NORTHERN AFFAIRS
AND IS MANAGED BY
THE ONTARIO MINISTRY OF NATURAL RESOURCES

Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Natural Resources does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

Publications of the Ontario Ministry of Natural Resources and price list are available through the *Map Unit, Public Service Centre, Room 6404, Whitney Block, Queen's Park, Toronto,* and the *Ontario Government Bookstore, 880 Bay Street, Toronto.*

Orders for publications should be accompanied by cheque or money order payable to the *Treasurer of Ontario.*

ISSN 0709-4671
ISBN 0-7743-4318-4

Parts of this publication may be quoted if credit is given. It is recommended that reference to this report be made in the following form:

Mollard, D.G. and Mollard, J.D.
1981: Frazer Lake Area (NTS 52H/SE), District of Thunder Bay; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 42, 30 p. Accompanied by Map 5052, scale: 1:100 000.

1200-80-H of C

CONTENTS

		Page
1.0	Introduction	1
2.0	Physiography and Geological Setting	2
3.0	Engineering Terrain Units	3
3.1	Bedrock Plateau (RL)	4
3.1.1	Description	4
3.1.2	Occurrence	4
3.1.3	Engineering and Planning Significance	4
3.2	Bedrock Knob (RN)	5
3.2.1	Description	5
3.2.2	Occurrence	5
3.2.3	Engineering and Planning Significance	5
3.3	Bedrock Plain (RP)	5
3.3.1	Description	5
3.3.2	Occurrence	6
3.3.3	Engineering and Planning Significance	6
3.4	Bedrock Ridge (RR)	6
3.4.1	Description	6
3.4.2	Occurrence	7
3.4.3	Engineering and Planning Significance	7
3.5	End Moraine (ME)	7
3.5.1	Description	7
3.5.2	Occurrence	7
3.5.3	Engineering and Planning Significance	9
3.6	Ground Moraine (MG)	9
3.6.1	Description	9
3.6.2	Occurrence	9
3.6.3	Engineering and Planning Significance	10
3.7	Hummocky Moraine (MH)	10
3.7.1	Description	10
3.7.2	Occurrence	10
3.7.3	Engineering and Planning Significance	10
3.8	Ice-Contact Delta (GD)	11
3.8.1	Description	11
3.8.2	Occurrence	11
3.8.3	Engineering and Planning Significance	11

Page

3.9 Esker (GE) 12
3.9.1 Description 12
3.9.2 Occurrence 12
3.9.3 Engineering and Planning Significance 13
3.10 Kame (GK) 13
3.10.1 Description 13
3.10.2 Occurrence 13
3.10.3 Engineering and Planning Significance 13
3.11 Outwash Plain (GO) 14
3.11.1 Description 14
3.11.2 Occurrence 14
3.11.3 Engineering and Planning Significance 14
3.12 Raised Beach Ridges (LB) 15
3.12.1 Description 15
3.12.2 Occurrence 15
3.12.3 Engineering and Planning Significance 15
3.13 Glaciolacustrine Delta (LD) 16
3.13.1 Description 16
3.13.2 Occurrence 16
3.13.3 Engineering and Planning Significance 16
3.14 Glaciolacustrine Plain (LP) 17
3.14.1 Description 17
3.14.2 Occurrence 17
3.14.3 Engineering and Planning Significance 17
3.15 Alluvial Plain (AP) 19
3.15.1 Description 19
3.15.2 Occurrence 19
3.15.3 Engineering and Planning Significance 19
3.16 Talus Slope (CT) 19
3.16.1 Description 19
3.16.2 Occurrence 20
3.16.3 Engineering and Planning Significance 20
3.17 Slopewash Sheet (CW) 21
3.17.1 Description 21
3.17.2 Occurrence 21
3.17.3 Engineering and Planning Significance 21
3.18 Organic Terrain (OT) 21
3.18.1 Description 21
3.18.2 Occurrence 22
3.18.3 Engineering and Planning Significance 22

Page

4.0 Appendix: Examples of Terrain Unit Letter Codes 23
4.1 Simple Terrain Unit 23
4.2 Complex Terrain Unit 24
5.0 References 28

FIGURE

1 – Map of the Quetico-Nipigon area showing moraines and orientation of glacial features 8

MAP
(accompanying report)

Map 5052 (coloured) – Northern Ontario Engineering Geology Terrain Study, Data Base Map, Frazer Lake (NTS 52H/SE). Scale 1:100 000.

Northern Ontario
Engineering Geology Terrain Study 42

FRAZER LAKE AREA

(NTS 52H/SE)

District of Thunder Bay

by

D.G. Mollard[1] and J.D. Mollard[2]

1.0 INTRODUCTION:

This report contains an inventory of regional engineering terrain conditions in the Frazer Lake map-area, District of Thunder Bay. The area, which covers NTS block 52H/SE, lies between Latitudes 49°00'N and 49°30'N and Longitudes 88°00'W and 89°00'W. This report forms part of a series of publications which provide similar terrain data for some 370 000 km^2 of northern Ontario.

The purpose of the mapping is to provide a guide for engineering and resource planning functions at a level of detail consistent with a scale of 1:100 000. The terrain information is contained on the Data Base Map (OGS Map 5052, accompanying this report).

[1]Consulting Engineering Geologist, J.D. Mollard and Associates Limited, Regina, Saskatchewan.
[2]Senior Consulting Engineer, J.D. Mollard and Associates Limited, Regina, Saskatchewan.

Manuscript approved for publication by the Chief, Engineering and Terrain Geology Section, March 17, 1980. This report is published with the permission of E.G. Pye, Director, Ontario Geological Survey.

Interpretation of black and white aerial photographs, at a scale of approximately 1:50 000, formed the basis of the terrain mapping process. The interpretation was checked against published and unpublished maps and reports which documented previous field visits and observations. During the fall of 1977, roads in the map-area were traversed and observed terrain conditions recorded as further verification of the office studies. Thus, the Data Base Map represents a reconnaissance overview of the engineering conditions of the terrain.

An engineering terrain legend was developed to facilitate the mapping and to provide a common information base for the entire map series. This legend is shown on the accompanying Data Base Map. Further discussion on the mapping techniques, legend format, and possible uses of this engineering geology information is available in the Ontario Engineering Geology Terrain Study Users' Manual (Gartner, Mollard, and Roed 1980), a companion publication to this series of maps and reports.

2.0 PHYSIOGRAPHY AND GEOLOGICAL SETTING:

The Frazer Lake map-area lies within the James Region of the Precambrian Shield (Bostock 1967). A small portion of the Port Arthur Hills physiographic unit of the above region crosses the southeast corner of the map-area. The Nipigon Plain unit forms a band around Lake Nipigon, while the Severn Upland occupies the remainder of the area.

The Port Arthur Hills are composed mainly of Early Precambrian felsic igneous and metamorphic rocks (granite, granite gneiss, and associated lithologies). Large areas of the Port Arthur Hills consist of bedrock exposures in the form of rock knobs, ridges, and plains.

The Nipigon Plain has formed on the Early Precambrian metasediments and metavolcanics and the essentially flat-lying Late Precambrian mafic sills which surround Lake Nipigon. This plain is deeply dissected, with remnants of resistant mafic sills standing out as widely scattered flat-topped hills with near-vertical margins.

The Severn Upland is underlain by Early Precambrian (Archean) crystalline rocks having a broad rolling surface. Large areas in the Severn

Upland consist of bedrock exposures surrounded by thin and patchy deposits of glacial sediments and muskeg.

Maximum elevations of greater than 535 m occur southeast of Pringle Lake in the southwestern part of the map-area and east of Keemle Lake in the east-central part. The minimum elevation of 184 m occurs on Kama Bay of Lake Superior, in the southeast corner of the map-area.

3.0 ENGINEERING TERRAIN UNITS.

The engineering terrain units mapped are identified in terms of four components: surface material, landform, topography, and drainage. Format of the legend used in the terrain mapping is described in detail in the Users' Manual (Gartner, Mollard, and Roed 1980). Landform is a very important component because surface and near-surface materials, topographic expression, and the surface and internal drainage conditions are all related to it. Consequently, the engineering terrain units are grouped, for descriptive purposes according to the dominant landform.

A particular landform can occur as the only component in a simple terrain unit, or as a dominant or subordinate component in a complex terrain unit. The dominant landform usually occupies more than half of a complex terrain unit. Where only one subordinate landform is shown, it usually occupies between 10 and 50 percent of the complex unit. Where two subordinate landforms are shown, the first covers the larger area. Landforms that occupy less than 10 percent of the terrain in a complex unit are rarely indicated in the terrain unit letter code. Where two or three landforms in a complex terrain unit consist of the same material, the landform letter symbols are connected by a dash. Examples of terrain unit letter codes which may occur in this map-area, and an explanation of each, are given in the Appendix.

A large number of complex terrain units has been mapped due to the widespread occurrence of irregular topography. Bedrock, which is situated at or near the ground surface throughout much of the map-area controls the topography and therefore the surface drainage conditions. Resource development and engineering planning considerations are complicated by these complex conditions.

Noteworthy occurrences of important landforms are described with respect to location, typical materials, topography, and drainage; their significance in geotechnical investigations, regional engineering planning and resource development is summarized.

3.1 BEDROCK PLATEAU (RL):

3.1.1 Description:

Areas mapped as bedrock plateau (RL) contain bold mesa-like features that have a capping of resistant rock consisting of eroded remnants of Proterozoic diabase sheets. The surface aspect of mesas and plateaus varies from nearly level to moderately sloping. Cliffs around part or all of these elevated features are strewn with coarse talus debris.

The surface of these landforms tends to be dry. Exceptions are the bottoms of long linear depressions. Usually these narrow trenches are partly filled with standing water or they contain organic deposits. Although bedrock plateau areas generally exhibit elevated planar slopes, they may still have knobby and jagged surfaces locally; these features can markedly affect engineering and construction costs.

The map user should note that this landform can occur in simple or complex terrain units (e.g. RL(MG/R)).

3.1.2 Occurrence:

Bedrock plateaus occur around Eileen Lake and Little Moraine Lake in the southwest corner of the map-area, east of Limestone Lake in the southeastern part, and west of Snell Lake in the central part of the area.

3.1.3 Engineering and Planning Significance:

Construction costs are generally high because slopes are steep and the presence of bedrock often necessitates blasting. Because bedrock plateau areas are aesthetically very pleasing, the possibility of developing small acreages, ski slopes, and sight-seeing tours holds considerable promise in some localities. Cliffs may be unstable since they are subject to rock falls. Road construction can be extremely difficult and costly in areas where the bedrock is highly uneven and is situated at or very near the surface.

On roadways, horizontal and vertical sight distances are generally low and can create a traffic hazard.

3.2 BEDROCK KNOB (RN):

3.2.1 Description:

Bedrock knob landscape (RN) is characterized by an irregular bedrock surface having complex multiple slopes of varying steepness. The cover of glacial deposits overlying the bedrock knobs is generally thin and discontinuous. Much of the glacial overburden consists of bouldery, sand-rich till that was transported only a short distance by the ice.

3.2.2 Occurrence:

Bedrock knob terrain occurs west of Black Sturgeon Lake and Little Sturge Lake on the western margin of the map-area, west and northeast of Nipigon in the southern part, and at several places along the eastern margin of the area.

3.2.3. Engineering and Planning Significance:

Two principal engineering considerations are the large volumes of rock that must be excavated during construction and the generally uniform and solid foundation conditions at shallow depths. However, due to difficult topography and the existence of rock fractures, bedrock knob terrain is considered poor for most types of light construction and for waste disposal. Drilling and blasting are required during the construction of almost all types of engineering works.

3.3 BEDROCK PLAIN (RP):

3.3.1 Description:

The bedrock plain unit (RP) has a low-lying, undulating to rolling surface. The bedrock is generally mantled by a thin and variable cover of glacial material, consisting mainly of boulder-rich, sandy till. The rock plains display considerable local variation. They may consist of bare bedrock or may be covered by till or fine-grained water-laid deposits.

3.3.2 Occurrence:

Large expanses of bedrock plain occur in the Frazer Lake map-area. A belt composed largely of this landform forms an arc, concave toward the southwest, extending from the northwest corner of the area to the south-central part. Bedrock plain is also the dominant landform in the southeast corner of the map-area and in a wide belt extending from Forgan Lake (at the south end of Lake Nipigon) to the eastern margin of the area.

3.3.3 Engineering and Planning Significance:

Engineering and construction problems relate mainly to the cost of bedrock excavation. Foundation materials are strong, have a low compressibility, and a permeability that is controlled almost entirely by rock fractures. Bedrock plains are poor construction and waste disposal sites, but are still considered better than areas mapped as bedrock plateau (RL), bedrock knob (RN), or bedrock ridge (RR). Drainage courses tend to follow eroded zones of weakness in the underlying bedrock. Many of these depressions occupy preglacial channels that were enlarged by glacial erosion. A large proportion of the ground water in this landform is confined to fractures in the upper 45 to 60 m of bedrock. Permeability varies from impervious to highly pervious, depending on the spacing, depth, and width of fissures in the bedrock. Rock materials have high compressive, shearing, and bearing strengths. Position of the water table varies with topography, being closer to the surface beneath depressions. By careful route selection and proper design of vertical alignment, rock cuts on lower class roads can be avoided or at least the volume of rock to be blasted can be minimized. This is possible because of the low relief surfaces associated with many of the bedrock plains.

3.4 BEDROCK RIDGE (RR):

3.4.1 Description:

The bedrock ridge unit (RR) consists of long, narrow, subparallel and intersecting bedrock ridges of varying height. Thickness of drift over the masked bedrock surface varies substantially over short distances. In general, it is relatively thin (1 to 2 m) on ridge tops and thicker on the lower slopes and in the depressions between rock ridges.

3.4.2 Occurrence:

Bedrock ridge units occur south of Little Sturge Lake on the western margin of the area, north of Elizabeth Lake in the central part, east of Pijitawabik Bay in the northeast corner, and scattered throughout the south-central part of the area (particularly in the Townships of McIvor, Purdom, Cockeram, Church, and Booth).

3.4.3 Engineering and Planning Significance:

The main construction problem is the large quantities of very hard rock that often must be excavated during construction. Drilling and blasting costs can be very high. Bedrock ridge terrain is considered poor for most types of engineering, construction, and resource development. It also has a low rating for waste disposal due to irregular relief, the presence of rock fractures near the ground surface, and the high cost of earthwork construction.

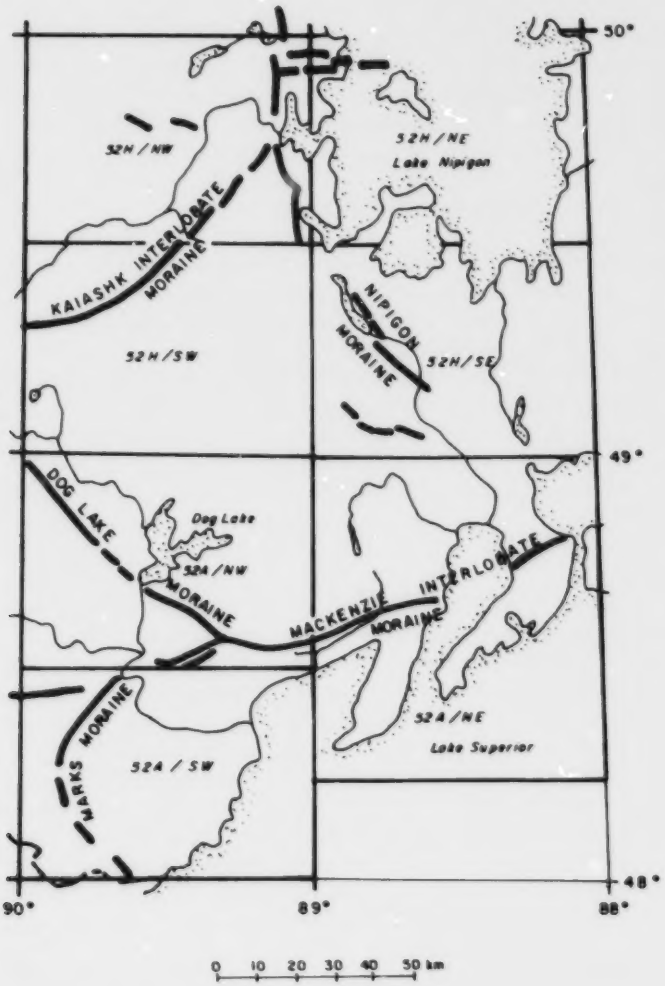
3.5 END MORAINE (ME):

3.5.1 Description:

End moraine (ME), which forms either prominent or inconspicuous till ridges, was deposited along the margin of the glacier. Although the ridges are usually long and narrow, they can be hummocky in places. End moraine consists largely of ice-deposited till and boulders, with minor inclusions of water-laid silt, sand, and gravel. Segments of end moraine, composed mainly of till, occur with hummocky moraine (MH), kames (GK), and ice-contact deltas (GD) in large moraine complexes which are identified by name in Figure 1.The bedrock surface is nearly always buried in areas of end moraine; there are exceptions, however, and in a few places end moraine ridges have a core of solid rock. The graphic symbol —●—●— is used to indicate major end moraines on the Data Base Map (OGS Map 5052, accompanying this report).

3.5.2 Occurrence:

End moraines, most of them trending in a northerly direction, occur 1) west of Black Sturgeon Lake, north of Linton Lake, and northwest of Krug Lake in the northwestern part of the map-area, 2) east of Disraeli



NOTE: Moraine segments shown in the figure do not necessarily all occur on the Data Base Map accompanying this report.

FIGURE 1 - MAP SHOWING MAJOR MORAINES IN NTS 52A AND 52H (MODIFIED FROM ZOLTAI 1965, FIGURE 3)

Lake and southwest of Pringle Lake in the southwestern part, and 3) southwest of Eskwanonwatin Lake in the central part of the area.

3.5.3 Engineering and Planning Significance:

An important characteristic of end moraines is their variability. Layers of unsorted and unstratified material of varying sizes (i.e. till), can both underlie and overlie sequences of layered silt, sand, and gravel. In general, the boulder content of this landform is high. End moraines in the map-area commonly exhibit variable permeability and internal drainage, low compressibility, and high bearing strength. The water table is low in end moraine ridges. Where the unit consists of till that is high in sand- and gravel-sized material, and where sources of stratified sand and gravel are scarce, the coarse till may sometimes be crushed and used as a source of road-surfacing material. End moraines may present excavation difficulties during the building of roads and structures due to the abundance of small and large boulders.

3.6 GROUND MORAINE (MG):

3.6.1 Description:

The term "ground moraine", (MG) refers to an extensive deposit of till forming an undulating to rolling plain. Although till is generally composed of an assortment of particle sizes (including clay, silt, sand, gravel, cobbles, and boulders), till deposits in this map-area have a high sand and boulder content. The thickness of till in ground moraine varies from less than 1 m to many tens of metres. The landform is mapped as MG where the till is thick enough to mask any topographic effect of underlying bedrock. In general, the till layer forms a mantle less than 3 m thick over the bedrock and is mapped as MG/R. Till in ground moraine tends to be thicker in bedrock depressions and thinner over bedrock ridges and knobs.

3.6.2 Occurrence:

Ground moraine, which occurs extensively throughout the Frazer Lake map-area, is generally found as a thin mantle over bedrock (MG/R), or in complex association with bedrock terrain (MG(R)). Thicker deposits of ground moraine till occur west of Sturge Lake and east of Shillabeer Lake in the southwestern part of the map-area.

3.6.3 Engineering and Planning Significance:

The till in ground moraine is coarse and bouldery, and has moderate permeability and internal drainage, low compressibility, and high bearing strength. Water table position varies with relief, being lower beneath knolls and low ridges, and higher beneath depressions. The till in many of the depressions is covered by thin deposits of peat and muck.

The suitability of ground moraine for road and other light foundation construction is fair to good. The fact that the till often forms only a thin mantle over the bedrock (MG/R) has a great deal of significance in road building. Road construction through this type of terrain is difficult owing to the bouldery nature of the till and the probability of encountering bedrock in cuts. The suitability of ground moraine for waste disposal varies from poor to fair.

3.7 HUMMOCKY MORAINE (MH):

3.7.1 Description:

Although some hummocky moraine deposits formed along an active ice front, most of the sediments which make up this landform accumulated on the surface of stagnant glacial ice. In time, the buried ice melted and deposited a layer of unsorted till and, in places, washed glacial debris. Most hummocky moraine consists of steep-sided knobs and short ridges separated by undulating to flat plains and swampy kettle hole basins. Soil materials in hummocky moraine include till, usually as the dominant constituent, and subordinate amounts of stratified silt, sand, and gravel in pockets or lenses. Hummocky moraine can be very bouldery. Scattered kames (GK) are a common subordinate landform.

3.7.2 Occurrence:

Hummocky moraine occurs northwest of Sturge Lake and in a long belt extending from Disraeli Lake eastwards into Cockeram Township. Both occurrences lie in the southwestern part of the map-area.

3.7.3 Engineering and Planning Significance:

Engineering considerations include the large quantities of material that

may have to be excavated during construction, a high content of boulders, and rapid changes in the nature of the materials. Pockets of sand and gravel constitute small sources of construction material of variable quality.

Although variable, most areas of hummocky moraine have moderate permeability and internal drainage, low compressibility, high bearing strength, and low shrink-and-swell potential. In depressions, the till deposits are commonly covered by thin, water-laid silt and clay, which in turn are overlain by peat and muck deposits. Hummocky moraine is considered fair to poor for general construction purposes and for waste disposal.

3.8 ICE-CONTACT DELTA (GD):

3.8.1 Description:

Esker deltas, kame deltas, and delta moraines are all varieties of the ice-contact delta. Some are quite large in area and important in terms of the volume of recoverable sand and gravel which they contain. Individual beds, consisting mainly of sand or gravel, are usually better sorted, cleaner, and less variable than stratified deposits in esker (GE) and kame (GK) landforms. The beds in this unit are also typically less folded and faulted and are more continuous. It is worth noting that materials in many ice-contact deltas are coarse (i.e. gravelly) on the north and northeast sides and finer (*i.e.* sandy) on the south and southwest sides. These conditions indicate the parts of the delta which were, respectively, closest to and farthest from the glacial front against which the delta was built.

3.8.2 Occurrence:

Ice-contact deltas are located 1) west of Pringle Lake in the southwestern part of the map-area, 2) extending southeast from the south end of Black Sturgeon Lake in the central part, 3) on the peninsula which protrudes into Lake Nipigon in the north-central part, and 4) south of South Bay (Lake Nipigon) in the central part of the area.

3.8.3 Engineering and Planning Significance:

Ice-contact deltas are good potential sources of concrete and blacktop

aggregate. They are also favorable sites for the construction of airstrips, roads, and other types of engineering works. Because the subsoils are highly permeable, deltaic (GD) landforms are relatively poor areas for waste disposal. Larger deposits, however, are generally good ground water prospects, especially where sand and gravel horizons are thick and extend below the water table. Ice-contact deltas possess high bearing strength and good workability in wet weather. Slopes are stable and subsoils are well drained. Away from the steeply sloping margins of this landform, earthwork volumes and excavation costs are normally low. Reservoirs and sewage lagoons in ice-contact deltas must be lined to prevent excessive leakage.

3.9 ESKER (GE):

3.9.1 Description:

The ridged landform represented by the esker symbol (GE, >>>) also includes crevasse fillings. Both occur as long, narrow, sand and gravel ridges that can be winding or straight and may widen in places. Some of these elongate ice-contact stratified drift ridges include braided, branching, beaded, and kettled segments. Most of the ridges trend roughly parallel to the last direction of glacial flow. The cores of many eskers and crevasse fillings contain complexly layered units, consisting of sandy gravel and gravelly sand, that exhibit collapse structures (*i.e.* folds, faults, and pinch-outs of strata). Pockets and layers of waterlaid silt and fine sand, boulders, and till may occur within the central parts of eskers and crevasse fillings, as well as along their flanks.

The crests of larger eskers are often shown by the graphic symbol <<<. Eskers too small to be mapped as a seperate terrain unit are represented by the graphic symbol only.

3.9.2 Occurrence:

Eskers are located west of Disraeli Lake on the western margin of the map-area, north of Black Sturgeon Lake in the northwest corner, south of McIntyre and South Bays of Lake Nipigon in the northern part, and west of Jessie Lake in the central part.

3.9.3 Engineering and Planning Significance.

Eskers and crevasse fillings are generally inferior to ice-contact delta and glacial outwash deposits as sources of good quality granular construction materials. Typically, the unit possesses high permeability and good internal drainage, low compressibility, high bearing strength, low frost susceptibility, and low shrink-and-swell potential. Where esker ridges are steep-sided, narrow, and winding, they may be unsuitable for use as transportation routes. They may trend in the wrong direction for route location purposes, but in regions that are dominated by large expanses of swamp and bedrock, large eskers are frequently considered as good route location possibilities. Where the sand and gravel in large eskers extends many metres below the water table, the unit represents a potential source of ground water for domestic and, possibly, municipal and industrial use.

3.10 KAME (GK):

3.10.1 Description:

Kames occur either as steep-sided single knobs or as clusters of several knobs in kame fields and kame moraine. The larger, steep-sided kames usually have an irregular surface; in a few places, they contain deep kettle hole depressions. Most are composed of complexly interbedded sand and gravel strata which regularly exhibit fold, fault, and pinch-out structures. Kames also contain variable but usually minor amounts of silt, till, and boulders. Large kame deltas are discussed in Section 3.8; kame terraces are rare.

3.10.2 Occurrence:

A large kame unit extends northwest from Nipigon into Booth Township in the southern part of the area. Smaller kame units occur south of Sturge Lake, east of Little Sturge Lake, and north of Shillabeer Lake, all of them in the southwestern part of the area.

3.10.3 Engineering and Planning Significance:

In general, kames have high permeability and good internal drainage, low compressibility, high shear strength, and good bearing capacity. Position

of the water table varies with relief, being nearer the surface beneath kettle depressions and deeper beneath ridges and knobs. Although the granular materials in kames provide good foundations for buildings and small engineering works, the quantities of material that must be excavated during construction can be moderately high. Waste disposal sites require special design procedures and costly construction in order to function properly. Kames should be avoided as waste disposal sites. They vary from poor to good as sources of sand and gravel aggregate, depending upon their size and compositional variability.

3.11 OUTWASH PLAIN (GO):

3.11.1 Description:

Outwash deposits include plains, fans, deltas, and valley trains of varying sizes, all consisting mainly of sand and gravel. Most outwash sediments were drained from the front of a melting glacier and accumulated in flooded lowlands and valley bottoms. Although most outwash deposits formed in proglacial positions, some accumulated over masses of stagnant glacier ice, resulting in pitted or kettled surfaces. Outwash landscapes that show abandoned channel scars, braid bars, or deep kettle holes are commonly coarse in texture (i.e. gravelly and cobbly rather than sandy).

3.11.2 Occurrence:

Outwash deposits are located west of Muskrat Lake on the western margin of the map-area, west of Ferguson Lake in the northwest-central part, south of Fog Lake and along the Black Sturgeon River in the southern part, and in a former spillway channel in the eastern part of the area.

3.11.3 Engineering and Planning Significance:

Outwash landforms almost always have high permeability and good internal drainage, low to very low compressibility, low shrink-and-swell tendencies, and high shear strength and bearing capacity, particularly where these granular deposits are confined. Granular materials in outwash landforms form stable slopes and are seldom susceptible to frost heave. Being level and well drained, the sediments in outwash plains are not easily eroded by running water. The boulder content is generally low. A high

water table can be expected beneath kettle depressions. Extensive outwash plains provide excellent sites for the construction of roads and airstrips, and are often good sources of concrete and bituminous aggregate. They are good potential sites for ground water development, particularly where the granular deposits are deep and are recharged by water from nearby lakes and rivers.

3.12 RAISED BEACH FORM (LB):

3.12.1 Description:

Raised beaches are generally thin and consist of bouldery, gravelly, and sandy wave- and current-transported materials deposited along the shores of former glacial lakes. The term "raised beach" denotes a landform marking the position of a former rather than present-day lake margin. Generally, the wave-washed materials were eroded from coarse till and glaciofluvial deposits consisting of sand, gravel, and cobbles.

3.12.2 Occurrence:

Raised beach ridges occur along the western and southern shores of Black Sturgeon Lake in the northwestern part of the map-area and south of Fire Hill Lake in the southeast corner of the area.

3.12.3 Engineering and Planning Significance:

The raised beach in this area is generally too thin and narrow to constitute a major source of granular construction material. Because it is nearly level, well drained, and slightly elevated above the surrounding terrain, it is a good feature to follow in route location if it happens to trend in the desired direction. The water table is generally high in this landform. Raised beaches have a high permeability, good internal drainage qualities, and low compressibility (*i.e.* small amounts of total and differential settlement of structures bulilt upon them). They usually have high shear strength and bearing capacity. They make poor waste disposal sites because of their limited area and the possibility of leakage which can lead to contamination of nearby surface or ground waters.

3.13 GLAIOLACUSTRINE DELTA (LD):

3.13.1 Description:

Materials in glaciolacustrine deltas range in texture from sandy gravel and coarse sand (gsLD, sLD) near the apex of the delta, where the glacial stream entered the lake, to fine sand and silty sand (smLD) in the distal portion of the delta. The finer materials at the distal end of the delta usually interfinger with, and grade into, finer glaciolacustrine lake bottom sediments (*see* Section 3.14). The grain size of material in glaciolacustrine deltas is dependent on the composition of the source material and on the size and gradient of the stream transporting the material. The good bedding characteristic of delta sediments is related to variations in streamflow and former lake levels. Individual beds are usually well sorted, uniform, and continuous. Because of these characteristics, glaciolacustrine deltas are generally good sources of granular material for construction purposes.

3.13.2 Occurrence:

Glaciolacustrine deltas occur 1) southwest of Black Sturgeon Bay and on the northeast shore of Black Sturgeon Lake in the northwest corner of the map-area, 2) on the southeast shore of Black Sturgeon Lake and southwest of Graydon Lake in the western part of the area, 3) southeast of McIntyre Bay (Lake Nipigon) in the north-central part, 4) south of Frazer Lake in the southern part, and 5) in northern Ledger Township in the eastern part of the area. This last deltaic deposit represents the point at which waters from the spillway channel, mentioned in Section 3.11, emptied into a glacial lake.

3.13.3 Engineering and Planning Significance:

Glaciolacustrine deltas are good potential sources of concrete and blacktop aggregate. They are also favourable sites for the construction of airstrips, roads, and other types of engineering works. Because the subsoils are highly permeable, this landform is a relatively poor area for waste disposal. Larger deposits, however, are generally good ground water prospects, especially where the sand and gravel horizons are thick and extend below the water table. Glaciolacustrine deltas possess high strength and good workability in wet weather and, if large enough, are favoured

sites for many types of resource development. Slopes are stable and subsoils are well drained. Reservoirs and sewage lagoons in glaciolacustrine deltas should be lined to prevent excessive leakage.

3.14 GLACIOLACUSTRINE PLAIN (LP):

3.14.1 Description:

Sediments in glaciolacustrine plains consist of varved and massive, fine-grained materials deposited in glacial lake basins of varying size and depth. The proportions of clay, silt, and sand deposited at any particular location in these basins varies with depth of water in the former lake, distance from former shorelines, and the size of particles washed into the lake. Most clay, silt, and sand lacustrine deposits contain minor inclusions of till and scattered dropstones which were rafted into the lake on pieces of ice. In places, wave and current action in former glacial lakes eroded the surface of till deposits, producing thin patches of washed sand, gravel, and boulders that rest on till or bedrock. In other areas, bedrock knobs and ridges are surrounded by pockets of glaciolacustrine sediment. Glacial lake deposits usually consist of clay and silt (cLP, cmLP, mcLP) which accumulated in deep offshore waters at a depth where the bottom was no longer affected by wave action (generally below 10 m). Closer to shore, and at points where rivers discharged sandy materials into the lake, the deposits usually consist of fine and medium sand with minor silt (sLP, smLP). Most of these sandy lacustrine deposits accumulated in deltaic environments.

3.14.2 Occurrence:

Sizeable glaciolacustrine plains occur around the shores of McIntyre Bay in the northern part of the map-area, around the southern end of Black Sturgeon Lake in the western part, and north of Nipigon in the southeastern part of the area.

3.14.3 Engineering and Planning Significance:

Glaciolacustrine clay deposits (cLP) have high water retention capacity, low permeability, and poor internal drainage. These characteristics are largely controlled by a network of closely spaced joints. Generally, these landforms possess low density, low bearing strength, and moderate to high compressibility, unless the fine-grained sediments have been

consolidated by the weight of overriding glacier ice or by the effects of desiccation. The clay sediments usually provide poor foundation conditions and can be difficult to work with heavy construction equipment during wet weather. Most clay plains in the map-area are level to gently sloping. The sides of river valleys which have been deeply incised into these fine deposits are frequently highly dissected and are susceptible to rill-and-gully erosion on freshly cut ditch slopes and highway back slopes. Higher and steeper natural and man-made slopes are subject to the development of small failures. Where these lacustrine materials carry a high proportion of silt or very fine sand, they are susceptible to frost heave and the formation of frost boils. Subsoil permeability ranges from low to nearly impervious; as noted above, this is largely dependent on the presence of a system of closely spaced joints. In locations where glaciolacustrine clay sediments are highly plastic, they have a tendency to shrink or swell with changes in moisture content. Bearing capacity, shear strength, and compressibility vary greatly with differences in previous loading history and, therefore, the natural moisture content. Bearing capacities can be low in wet areas, particularly where plastic clay soils are normally consolidated or only slightly consolidated.

Low-lying clay plains have a high water table and are subject to local flooding during spring runoff and heavy cloudbursts. During wet weather, the glaciolacustrine clay sediments have poor workability characteristics for building roads and structures. This landform usually provides good sites for waste disposal because of its low permeability.

Lacustrine sand plains (sLP) contain mostly fine and medium sand with minor silt. Coarse sand, gravel, cobbles, boulders, and till are rare in these deposits. Sand plains are gently sloping to undulating and are well drained. A high water table may occur at sites located some distance from the ground water lowering effects of deep valleys and ravines. Sandy lacustrine materials are typically nonplastic and have high permeability, low compressibility, moderate to high bearing capacity, and high shear strength. They are generally not frost susceptible unless they contain significant amounts of silt and very fine sand. They represent fair to good terrain for most construction, especially that of roads and airstrips. They are poor for waste disposal due to the possibility of effluent seepage and ground water contamination.

3.15 ALLUVIAL PLAIN (AP):

3.15.1 Description:

Many alluvial deposits (AP) in this map-area consist of fine and medium sand at depth; these materials are commonly overlain by a silty upper stratum of variable thickness. Oxbows and abandoned channel segments occur where meandering streams cross landforms composed largely of loose silt and fine sand. Sediments beneath alluvial plains are finer textured where the material being carried by the stream was eroded from clay and silty clay glaciolacustrine deposits. The landform includes flood plains that have been eroded in till and are strewn with boulders, as well as segments of stream valleys where alluvial sediments range in texture from coarse sand to coarse gravel and cobbles. Long and complex alluvial plain systems sometimes include three constituent landforms: low alluvial terraces, alluvial flood plains, and stream channels.

3.15.2 Occurrence:

Alluvial plains are located 1) south of Black Sturgeon Bay and on the east shore of Black Sturgeon Lake in the northwest corner of the map-area, 2) on the west shore of Muskrat Lake near the western margin of the area, and 3) on parts of the Spruce River and Black Sturgeon River, south of Black Sturgeon Lake in the western part of the area.

3.15.3 Engineering and Planning Significance:

Alluvial plains are subject to flooding. The water table is usually situated at or near the surface for much of the year; organic-filled depressions are common. Although some alluvial terraces, flood plains, and channel bottoms represent potential sources of sand and gravel for construction purposes, the high water table may cause problems during excavation of such materials. This landform is generally unsuitable for transportation routes, general construction, or waste disposal sites because of the high water table and risk of flooding.

3.16 TALUS SLOPE (CT):

3.16.1 Description:

Pieces of broken rock that have fallen from cliffs and accumulated in piles

along the base of near-vertical rock faces are mapped as talus slopes (CT). Topples (rotated or tilted pieces of rock that have not fallen) and rock falls are common phenomena in this environment and can be hazardous. Angular pieces of rock vary from several centimetres to more than a metre in size. The talus debris is usually composed of only one type of rock (*i.e.* the lithology that forms the cliff above the talus slope). In this map-area, that lithology is commonly diabase.

The material which comprises the talus slope has been called rubble and is denoted by the letter r. Downslope from the base of talus piles, scattered pieces of rock have come to rest on sandy to gravelly slopewash deposits that are usually sandy, poorly sorted, and "dirty looking". In many places, blocks of talus are enclosed in slopewash material.

Some talus slopes too small to be mapped as a separate terrain unit are depicted only by the graphic symbols ▲▲ △△ .

3.16.2 Occurrence:

Talus slopes occur on the flanks of Fire Hill in the southeast corner of the area and on the slopes above the former spillway channel extending from Orient Bay (Lake Nipigon) to Wanogu Lake in the eastern part of the area. Talus piles are inferred to occur atop the slopewash sheet surrounding Moseau Mountain on the southern margin of the area.

3.16.3 Engineering and Planning Significance:

Heavy construction work on loose, angular blocks of talus can be hazardous because of (1) the possibility of intermittent rock falls and (2) the slope instability associated with the removal of blocks that support overlying pieces of talus. Most talus deposits possess an open structure with large voids and are thus highly pervious. The rock in talus piles represents a possible source of crushed aggregate for railway ballast and riprap. Permanent engineering structures should not be constructed on thick piles of talus because of the hazards mentioned above and the possibility of talus creep.

3.17 SLOPEWASH SHEET (CW):

3.17.1 Description:

Slopewash sheets are almost always poorly expressed in airphotos. The presence of these sheets must therefore be inferred from depositional environments that are recognizable on the photos. They usually contain poorly sorted, poorly stratified, loosely deposited sediments that have been washed down the surfaces of moderately steep slopes by unconcentrated overland sheet flow or transported down steep slopes by frost action and soil creep processes. Most of these materials were probably transported and deposited in a periglacial climate. Slopewash deposits commonly merge upslope with piles of talus debris and downslope with till and fine-grained lacustrine sediments.

3.17.2 Occurrence:

Slopewash sheets occur 1) south of Disraeli Lake, north of Seagull Lake, west of Moraine Lake, and east of Pringle Lake, all in the southwest corner of the map-area, 2) east of Eskwanonwatin Lake in the central part, 3) northeast of Jessie Lake in the eastern part, and 4) east of Pijitawabik Bay in the northeast corner of the area.

3.17.3 Engineering and Planning Significance:

Pits in this landform contain poorly sorted, poorly graded, dirty (silty) sand and angular rock particles of varying sizes. The material is usually too dirty to use as concrete or blacktop aggregate without being washed. Nevertheless, where these deposits are sufficiently thick and dry, the material can be crushed to produce a satisfactory road surfacing material. In general, slopewash deposits are thin and loose, and may possess a loose openwork (*i.e.* porous) structure. Subsoils are often wet, even though the slopes may appear steep enough to be well drained. Seepages and springs are common occurrences. Engineering problems caused by slopewash terrain include poor geometrics in road design and relatively high cuts and fills during construction.

3.18 ORGANIC TERRAIN (OT):

3.18.1 Description:

Organic terrain includes varying depths of peat and muck in marshes,

swamps, fens, and bogs. No attempt was made to separate these organic landscape types during the mapping. Although peat and muck deposits usually occur as relatively thin surficial layers, in places these organic materials can be several metres thick. Moreover, the thickness of the deposits can change drastically over very short distances.

3.18.2 Occurrence:

Organic terrain occurs extensively in poorly drained depressions throughout the Frazer Lake map-area, particularly around Shillabeer Lake in the southwestern part and near Lake Superior in the southeast corner.

3.18.3 Engineering and Planning Significance.

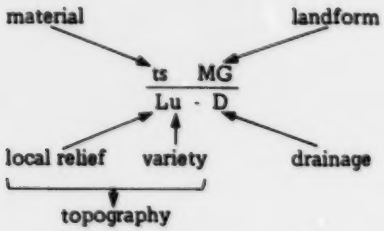
Although organic deposits are commonly thin, they are nonetheless very poor foundation and construction materials. The water table is at or near ground surface for most of the year. The locations of deeper pockets of organic material are difficult to predict reliably without extensive test-drilling. The topography of organic terrain is level or slightly depressional. Peat and muck deposits have low shear and bearing strengths and generally low permeability. They are nearly always poorly drained, highly compressible, and are subject to seasonal flooding. Consequently, they are unsuitable for nearly all types of engineering works and for waste disposal.

4.0 APPENDIX: EXAMPLES OF TERRAIN UNIT LETTER CODES:

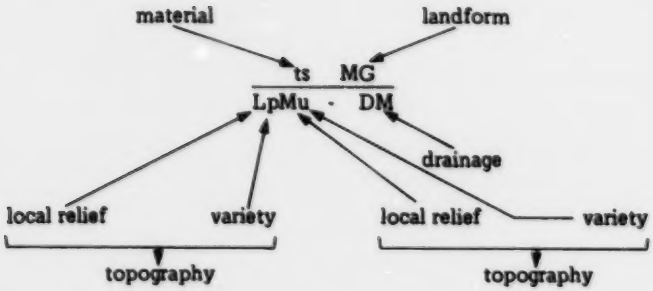
The engineering terrain unit letter codes consist of four components: surface materials, landform, topography, and drainage. The format of the letter codes used in describing the terrain units is discussed in detail in the Users' Manual (Gartner, Mollard, and Roed 1980). Some additional examples of the letter codes are as follows:

4.1 SIMPLE TERRAIN UNIT:

Example 1:



Example 2:

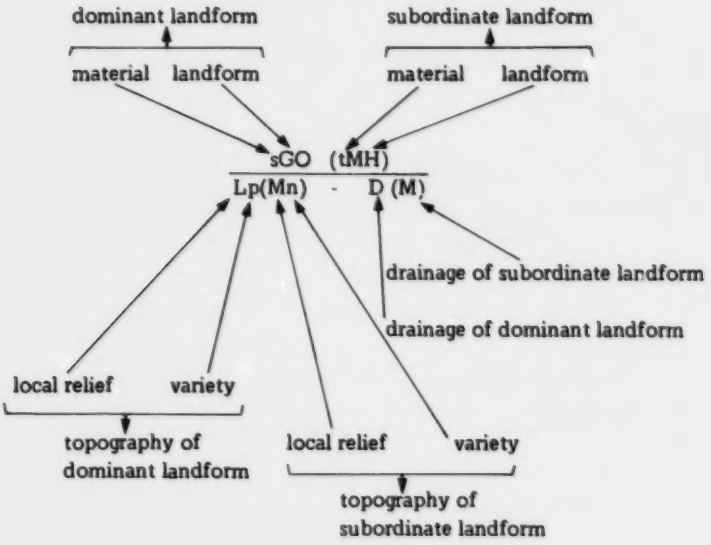


Note: The above type of letter code is used where there are two distinctly different types of topography and/or drainage in a simple terrain unit.

4.2 COMPLEX TERRAIN UNIT:

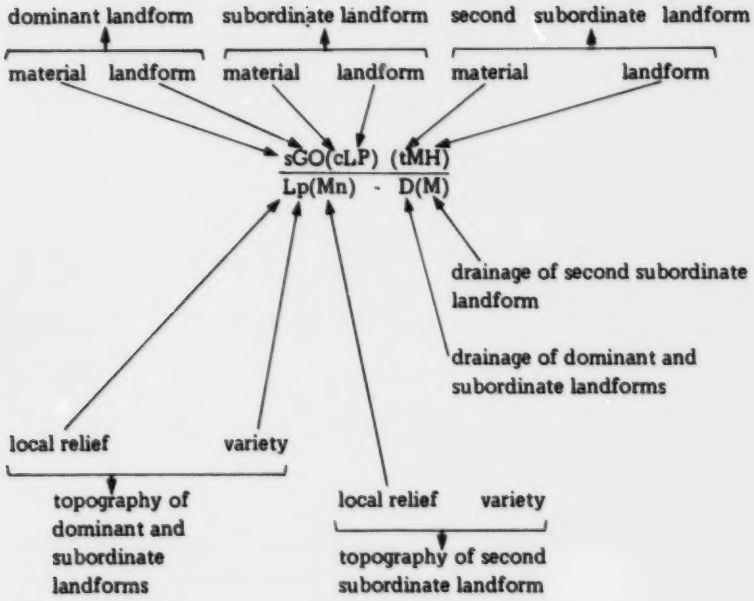
In complex areas, the dominant landform is shown first and the subordinate landform(s) appear in parentheses.

Example 1:



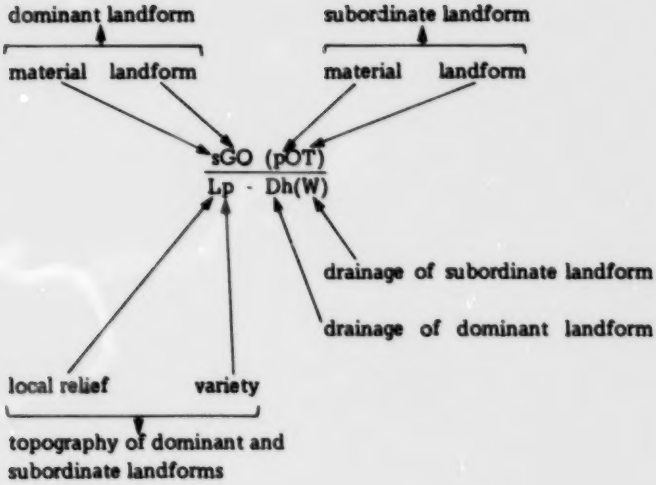
Note: The topography and drainage in parentheses refer to the landform shown in parentheses.

Example 2:



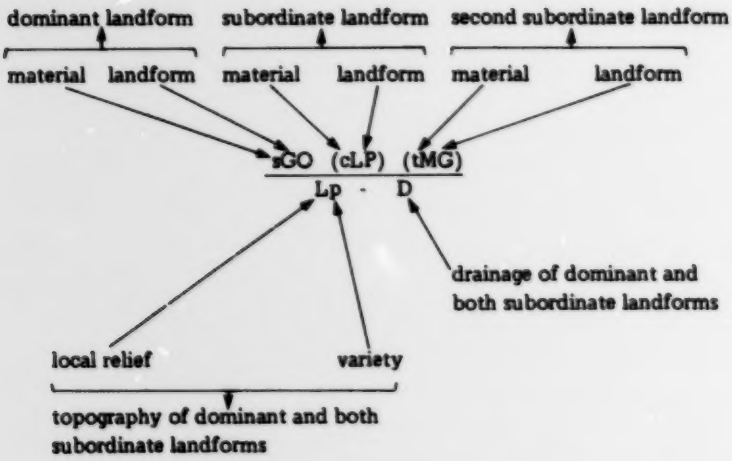
Note: The topography and/or drainage in parentheses refer to the second subordinate landform (in parentheses).

Example 3:



Note: If topography or drainage is similar in the dominant and subordinate landforms, then no topography or drainage symbol is shown in parentheses and the symbol shown applies to both landforms. If topography or drainage conditions are different in one of the landforms, a topography or drainage symbol is shown in parentheses to indicate this difference.

Example 4:



Note: Where topography and drainage conditions are similar in all of the landforms shown, no topography or drainage symbols are placed in parentheses.

5.0 REFERENCES:

Bird, J. Brian

1972: The Natural Landscapes of Canada – A Study in Regional Earth Sciences; Wiley Publishers of Canada Limited, Toronto, 191 p.

Bostock, H.S.

1970: Physiographic Regions of Canada; Geological Survey of Canada, Map 1254A, scale 1:5 000 000. Compilation 1967.

Canada Department of Agriculture

1972: Soils of Canada; Soil Research Institute, Research Branch, Canada Department of Agriculture, scale 1:5 000 000.

Carter, M.W., McIlwaine, W.H., and Wisbey, P.A.

1973: Nipigon-Shreiber, Thunder Bay District; Ontario Division of Mines, Map 2232, Geological Compilation Series, scale 1:253 440 or 1 inch to 4 miles. Revised compilation 1970-1971.Original compilation by E.G. Pye, 1966.

Douglas, R.J.W.

1969: Geological Map of Canada; Geological Survey of Canada, Map 1250A, scale 1:5 000 000. Compiled 1966, 1967.

Farrand, W.R.

1960: Former Shorelines in Western and Northern Lake Superior Basin; unpublished Ph.D. thesis, University of Michigan, Ann Arbor, 226 p.

Fremlin, Gerald (editor)

1974: The National Atlas of Canada, Fourth Edition (Revised); MacMillan Company of Canada Limited in association with the Canada Department of Energy, Mines and Resources and Information Canada, 254 p.

Gartner, John F., Mollard, J.D., and Roed, M.A.

1980: Ontario Engineering Geology Terrain Study Users' Manual; Ontario Geological Survey, Open File Report 5288, 99 p.

Gentilcore, R.L. (editor)

1972: Studies in Canadian Geography: Ontario; University of Toronto Press, Toronto, 126 p. (reprinted 1974).

Guillet, G.R.

1978: Special Minerals: Clay and Marl Utilization in NTS 52H; unpublished report for Gartner Lee Associates Limited, Toronto-Buttonville Airport, Markham, Ontario.

Hageraats, H.M.

1971: Landscape and Site Development; Design Branch, Canada Department of Public Works, 88 p.

Hills, G.A.

1961: The Ecological Basis for Land-Use Planning; Research Branch, Ontario Department of Lands and Forests, Research Report No. 46, 204 p.

Prest, V.K.

1969: Retreat of Wisconsin and Recent Ice in North America; Geological Survey of Canada, Map 1257A, scale 1:5 000 000. Compiled 1969.

Prest, V.K., Grant, D.R., and Rampton, V.N.

1968: Glacial Map of Canada, Geological Survey of Canada, Map 1253A, scale 1:5 000 000. Compiled 1964-1966.

Pye, E.G.

1966: Red Rock-Pine Portage Sheet, District of Thunder Bay; Ontario Department of Mines, Preliminary Map P.357, Geological Compilation Series, scale 1 inch to 2 miles. Geological compilation 1966.

1968: Geology and Scenery, Rainy Lake and East to Lake Superior, Ontario Department of Mines, Geological Guidebook No. 1, 118 p.

1969: Geology and Scenery, North Shore of Lake Superior, Ontario Department of Mines, Geological Guidebook No. 2, 144 p. (Reprinted 1975).

Rowe, J.S.

1972: Forest Regions of Canada, Department of the Environment, Canadian Forestry Service, Publication No. 1300, 172 p.

Saarnisto, Matti

1974: The Deglaciation History of the Lake Superior Region and its Climatic Implications; Quaternary Research, Vol. 4, No. 3, p. 316-339.

1975: Stratigraphical Studies on the Shoreline Displacement of Lake Superior; Canadian Journal of Earth Sciences, Vol. 12, No. 2, p. 300-319.

Skinner, R.G.

1969: A Summary of the Quaternary Stratigraphy of Northern Ontario, Canada; University of Washington, Seattle, Washington.

Wilson, Alfred W.G.

1910: Geology of the Nipigon Basin, Ontario; Canada Department of Mines, Geological Survey Branch, Memoir 1, 152 p.

Zoltai, S.C.

1962: Glacial History of Part of Northwestern Ontario, Proceedings of the Geological Association of Canada, Vol. 13, p. 61-83.

1965a: Glacial Features of the Quetico-Nipigon Area, Ontario, Canadian Journal of Earth Sciences, Vol. 2, No. 4, p. 247-269.

1965b: Surficial Geology, Thunder Bay, Ontario Department of Lands and Forests, Map S265, scale 1:506 880 or 1 inch to 8 miles. Surficial geology 1958-1960.

MAPS
NOT
FILMED

CARTES
OMISES